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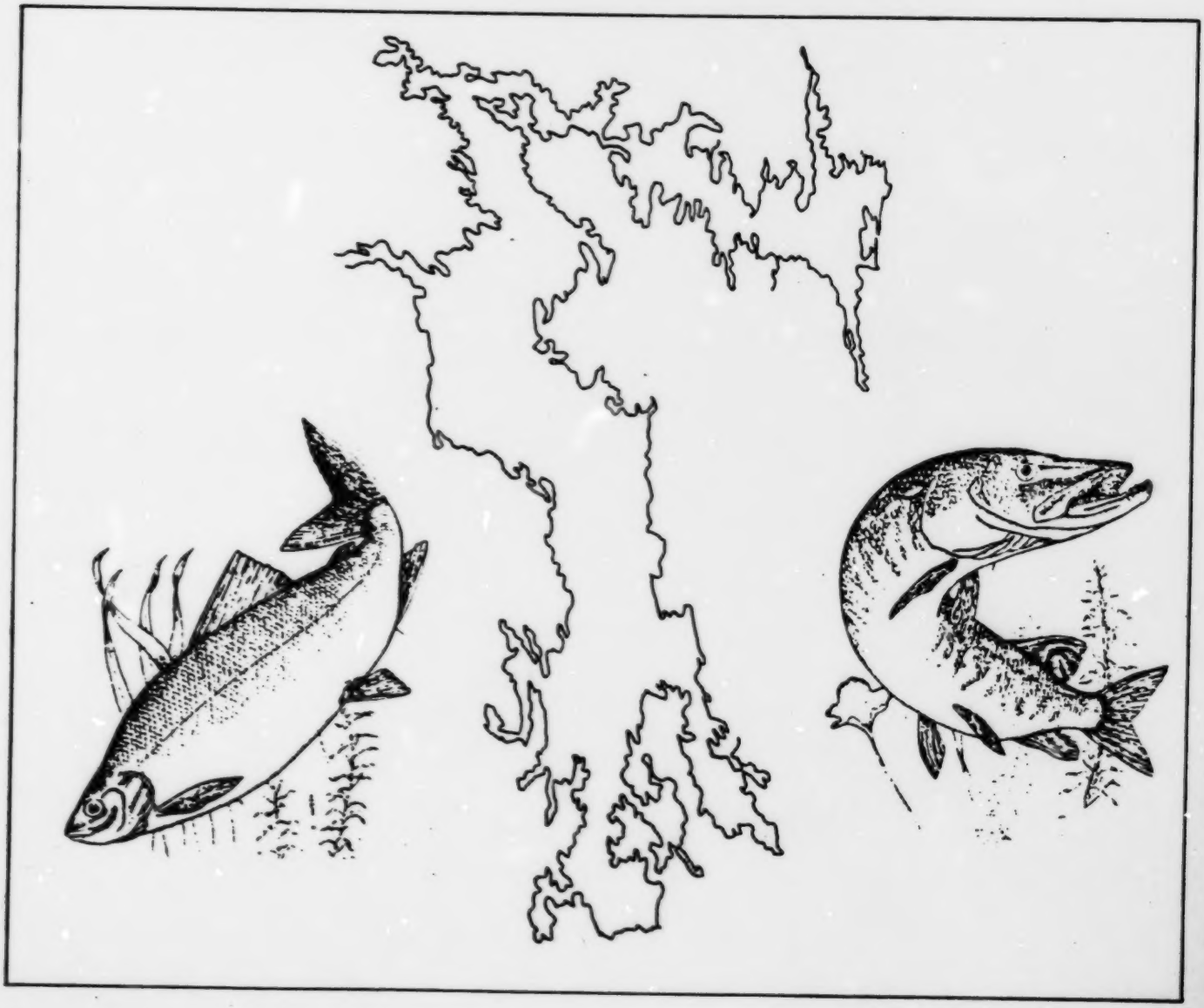
Northern Lakes Fish Monitoring Program:

Mirond Lake - 1989

Technical Report 90 - 3



Northern Lakes Fish Monitoring Program

Mirond Lake - 1989

BY

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FISHERIES TECHNICAL REPORT 90-3
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EXECUTIVE SUMMARY

A fisheries investigation was carried out on Mirond Lake during the summer of 1989 for the purpose of evaluating the current status of the resource. This report deals with the results from that investigation and compares them to results obtained from a similar study conducted in 1963-64.

Mirond Lake is situated in east central Saskatchewan, approximately 80 km west of Flin Flon, Manitoba, near the southern border of the Precambrian Shield. It has an area of 10 880 ha, a maximum depth of 45.5 m and a mean depth of 14 m.

Eight species of fish were caught in a total of 10 gillnet sets. Ciscoes were the most abundant followed by lake whitefish. These two species collectively made up 65% of the total catch. Forty northern pike, 6 walleye and only one perch were caught in the nets. These 3 species contributed to only 3% of the catch. Two species of suckers and burbot made up the remainder (32%). No lake trout were caught in the test nets in 1989.

The lake whitefish population in Mirond Lake is healthy but under harvested. Numerous age groups with an abundance of older fish, were well represented in the gillnet catch. Growth rate was slow and sexual maturity was generally achieved no later than 6 years of age; it could be delayed to as late as 8 years in some females.

Walleye were not well represented in the gillnet catch as a result of a sampling effort restricted to areas of the lake 10 m or greater in depth. This also resulted in an underestimate of the abundance of northern pike. Numbers of pike caught suggest a decrease in abundance between study years, with the majority of fish falling into the 5-7 year age classes. Younger fish were not present in the test net locations. Growth rate appeared to be very rapid in the first 5 years of life and maturity was achieved some time before age 5.

Mirond Lake has been subjected to commercial fishing since 1932. Since that time, the number of licenses issued annually has ranged from 1 to 34. During the 1940's, 50's, and 60's, quotas remained steady at 45 400 kg. The current commercial quota, set in 1968, is 36 300 kg with a 10% tolerance limit on gamefish species. The average annual production peaked in the 1930's (55 700 kg/yr) and remained fairly close to the recommended quota during the 50's and 60's. Since the 1960's, annual commercial production has been declining, reaching a low of 7100 kg during the 1980's. Whitefish in this lake are of low market value due to high infestations of *Triaenophorus crassus* cysts in their flesh. Changes to commercial regulations on this lake will not benefit the fishery until infestation rates are reduced.

Records of Indian harvests are available for 1984-1989, during which time the estimated average annual harvest was 12 620 kg.

The angler harvest for 1988, based on the potential use by the 3 licensed outfitters on the lake, was estimated at 19 600 kg of walleye and 25 000 kg of pike.

Compared to the historical commercial harvest records the estimate of maximum sustainable yield of whitefish (8700 kg) is relatively low. Test net data indicate the current whitefish population is underharvested. Maximum sustainable yields for walleye and pike suggest that total allowable catch not exceed 4000 kg and 6500 kg, respectively. Based upon verbal reports from Mirond Lake anglers, as well as estimates of harvest for 1988, these limits are well below current harvest levels.

The present data are inadequate to properly assess the Mirond Lake sport fishery. Too few walleye were caught to make any statement about the status of the population. Age structure of the pike caught suggest that only the older, larger, and more slowly growing portion of the population was sampled in the deep net sets and provides no information pertaining to the level of reproduction occurring.

Recommendations, based on the findings of this report include:

1. Retention of the current commercial quotas and harvest regulations.
2. A survey of the recreational fishery and the native fishery to obtain accurate information on the angler and Indian harvests from Mirond Lake in both summer and winter seasons.

3. Testnetting of depths less than 10 m to obtain a more representative assessment of the lake, particularly with regard to walleye and northern pike stocks.
4. Maintain the present recreational allocation levels until such time that a more representative assessment of the resource can be made.
5. Derive a method for determining estimates of maximum sustainable yield that can be confidently used in determining total allowable catch.
6. Ensure that future fish monitoring studies are designed to adequately sample all depth zones of the lake under consideration.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

An investigation into the fish resources of Mirond Lake was carried out from June 21 to July 26 in 1989. The study was conducted by the Saskatchewan Fisheries Laboratory, Fisheries Branch, Saskatchewan Parks and Renewable Resources. A study done in 1963-64 provided comparative baseline data for the current study.

There are presently 2 privately owned campgrounds and 3 licensed outfitters located on Mirond Lake. In 1989, only one of these outfitters contributed substantially to the angling pressure on the lake. Other recreational activities include canoeing and big game hunting.

The commercial fishery on the lake dates back to 1932. A quota of 34 000 kg, including lake whitefish, walleye, and lake trout, was initially set in 1941. In 1968, the current commercial quota was established at 36 300 kg, and included a 10% tolerance limit on trout, walleye, and northern pike.

The primary objective of this study was to assess the current status of the fishery resource in Mirond Lake in relation to that which existed 25 years ago and to use the information as a basis for future management decisions.

2. DESCRIPTION OF THE STUDY AREA

Mirond Lake (55°06'102°47') is situated in east central Saskatchewan approximately 80 km west of Flin Flon, Manitoba (Fig. 1). It is the northeastern member of a small three lake chain, which includes Jan and Pelican lakes, and forms part of the North Saskatchewan River drainage basin. Surrounded by scenic wilderness, Mirond Lake lies adjacent to the southern border of the Precambrian Shield and drains approximately 10 500 km^2. This drainage includes those of Pelican, Belcher, Attitti, and Waskwei lakes in addition to 38 small streams.

Mirond Lake has a north-south orientation and covers an area of 108.8 km^2, or 10 880 ha (Table 1). Mean depth of the lake is 14 m and the maximum depth is 45.5 m (Johnson, 1967). While there are numerous (248) small islands in Mirond Lake, about half of them are in the northern part known as Wunehikun Bay, leaving the main body of Mirond Lake exposed and potentially dangerous to small craft on windy days.

3. METHODS

In 1989, fish species in Mirond Lake were sampled using 10 standard gang sets. A standard gang is 276 m in length and has 46 m each of 3.8 cm, 5.1 cm, 7.6 cm, 10.2 cm, 12.7 cm and 14.0 cm mesh sizes. It has long been accepted as the standard measure for the evaluation of

Fig. 1. Map showing the relative location of Jan-Pelican-Mirond lakes.

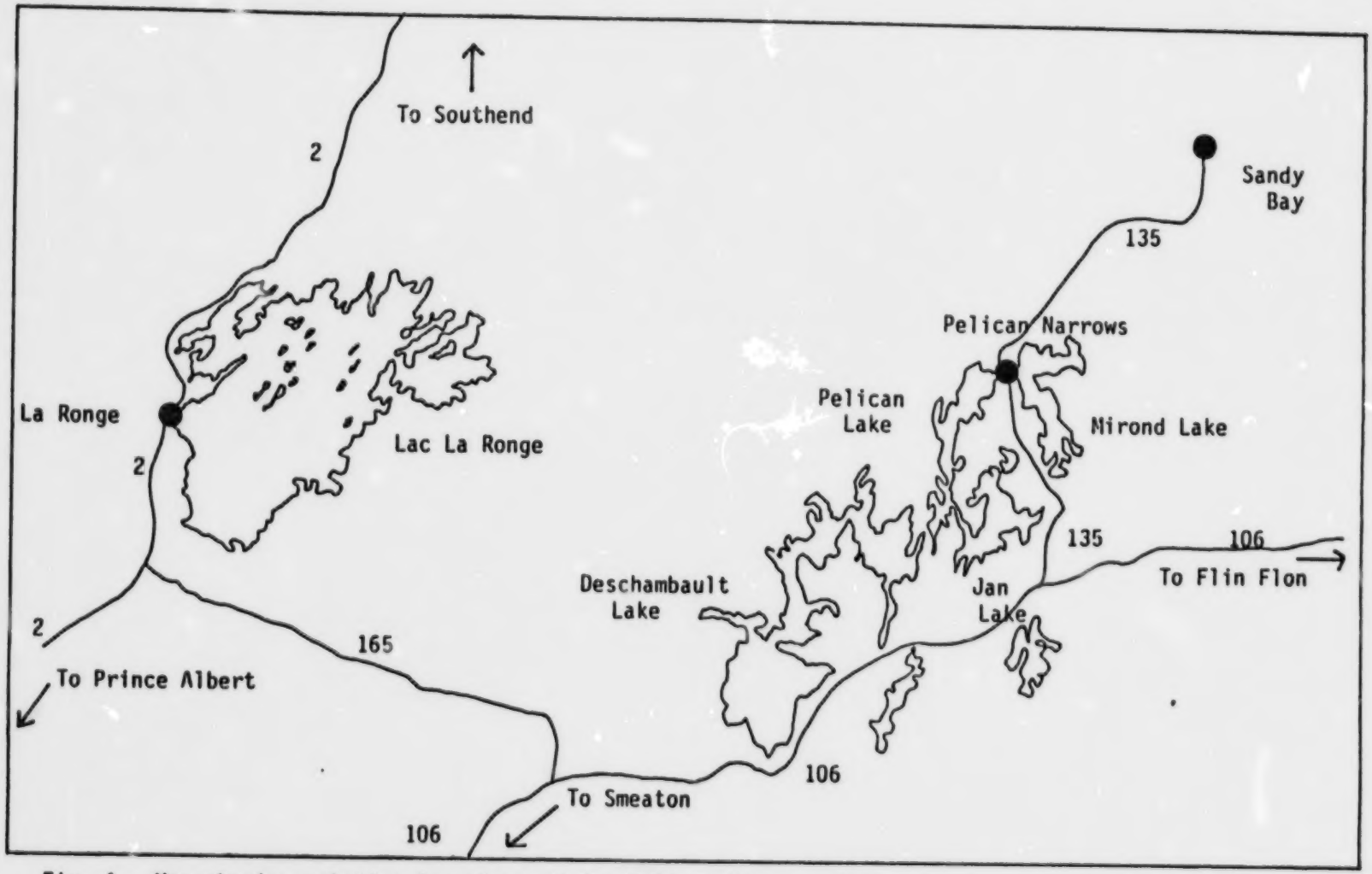

Fig. 1 Map showing relative locations of Jan-Pelican-Mirond Lakes.

Table 1. Distribution of depth zones in Mirond Lake. (Adapted from Johnson, 1967).

Depth zone, m	Area		Lake volume	
	km^2	%	$x10^8$	%
0-5	26.44	24.3	4.74	31.5
5-10	23.07	21.2	3.52	23.4
10-15	18.50	17.0	2.48	16.5
15-20	8.38	7.7	1.82	12.1
20-25	8.38	7.7	1.4	9.3
25-30	15.23	14.0	0.81	5.4
30-35	8.27	7.6	0.24	1.6
35-40	0.33	0.3	0.02	0.1
40+	0.22	0.2	+	-
Total	108.8		15.03	
Mean depth, m	14			
Maximum depth, m	45.5			

populations of large fish in Saskatchewan. Each net remained set for approximately 24 hours after which time it was lifted and picked. The nets were set in the same areas of the lake in which 10 of 12 nets were set in an earlier study conducted in 1963-64 (Fig. 2). Due to time constraints, it was not possible to duplicate the dates of the net sets. In addition, two nets set in Wunehikun Bay in 1963-64 were not duplicated in 1989.

Fork lengths (to the nearest millimeter) and weights (to the nearest gram) were recorded for all individuals of economically important species (i.e. walleye, lake whitefish, trout, and northern pike). Sex was determined and state of maturity was defined as immature, mature or, when possible, spent (post spawning). Stomach contents were inspected visually in the field. Other fish, including ciscoes, perch, suckers, and burbot, were counted and maximum and minimum lengths and total weights were recorded. Individual lengths and weights were recorded for a representative sample.

Aging media were taken from a characteristic sample of recreationally and economically significant species. In addition to scales, which were taken from all the fish, cleithra were taken from northern pike. Procedures used in the preparation and analysis of these media are described in Musker (1985).

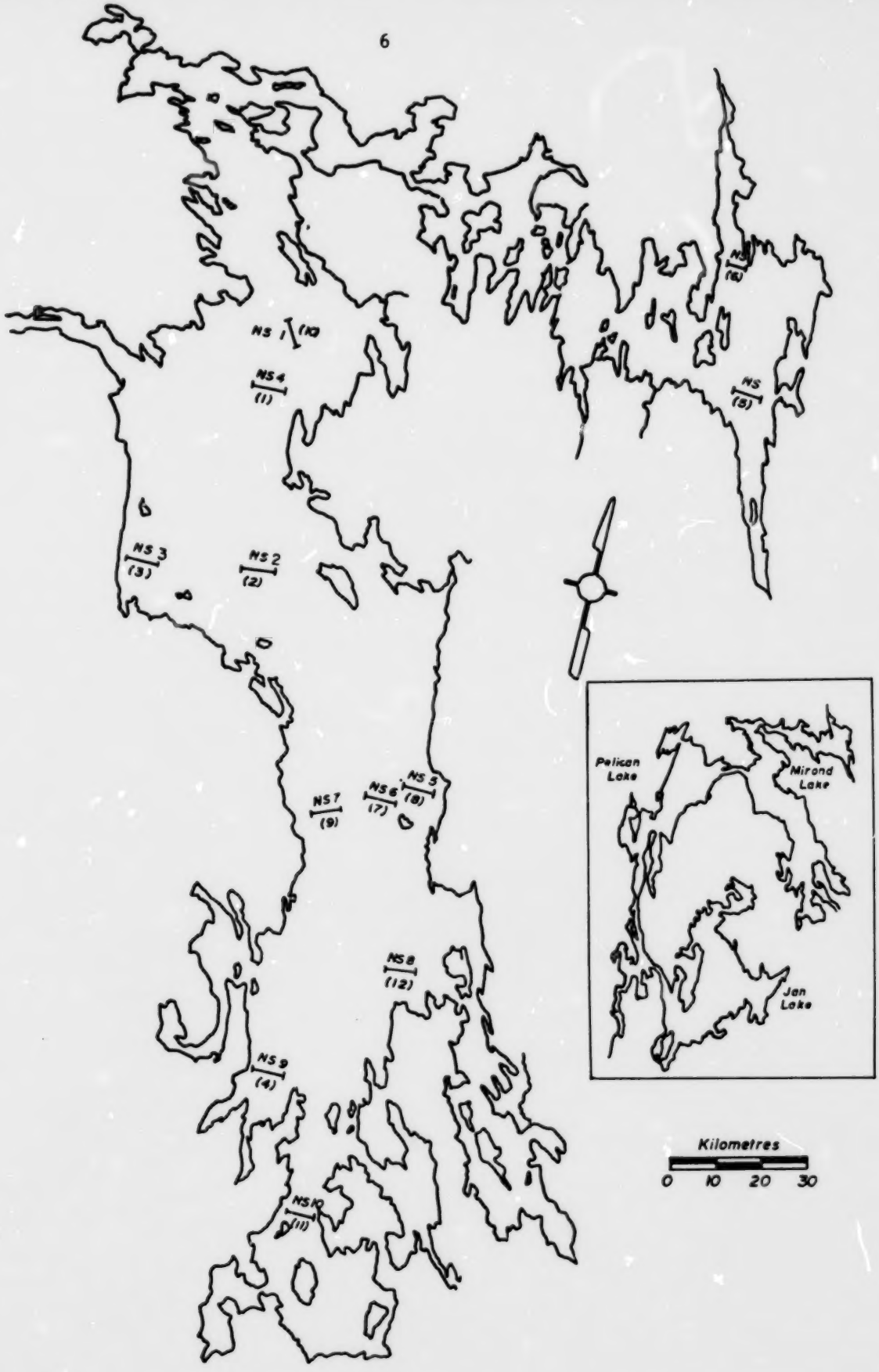

Fig. 2 Location of gillnet sets in Mirond Lake in 1963-64 (net number in parenthesis) and 1989.

4. RESULTS

4.1 SPECIES COMPOSITION AND RELATIVE ABUNDANCE

Eight species of fish were removed from gill nets in Wirond Lake in 1989 and 1963-64. The total numbers of fish caught were 1500 and 2016, respectively (Table 2). Average catch in 1989 was 150 fish per standard gang of gillnet as compared to an average of 168 fish per net in 1963-64. Analysis of the mean number of fish caught per net set in 1963-64 revealed no difference between the numbers caught in 12 nets compared to the numbers caught in 10 nets ($p<0.05$ t-test). Subsequently data collected from all 12 nets from the earlier study were used in comparisons made throughout the following.

Based on catch per standard gang of gillnet, lake whitefish numbers and sucker numbers showed as much as a 43% increase between years, while cisco numbers decreased by 25%. Discounting 60% of the northern pike catch which was taken from Wunehikun Bay in 1963-64, northern pike numbers in 1989 were still 28% less per net than those in the earlier study. Total gamefish (i.e. walleye and northern pike) abundance decreased by an average of 10.5 fish per net set. In 1989, burbot numbers were more than double what they were in 1963-64. Only 1 yellow perch and 6 walleye were caught.

In both 1989 and 1963-64, ciscoes were the most abundant in the gill nets (Fig. 3). This was followed, in order of abundance, by

Table 2. Summary of fish species caught in gill nets in Mirond Lake in 1989 and 1963-64. (Wt is weight in kg)

Species	1989		1963-64	
	No.	Wt.	No.	Wt.
Longnose sucker	163	105.9	152	69.0
Catostomus catostomus	(10.9)*	(14.1)	(7.5)	(9.8)
Common white sucker	176	133.7	175	99.1
Catostomus commersoni	(11.7)	(17.8)	(8.7)	(14.0)
Cisco	733	164.7	1165	163.5
Coregonus artedii	(48.9)	(21.9)	(57.7)	(23.2)
Lake whitefish	255	132.9	214	81.4
Coregonus clupeaformis	(17)	(17.7)	(10.6)	(11.5)
Northern pike	40	98.0	139	208.7
Esox lucius	(2.7)	(13.0)	(6.9)	(29.5)
Burbot	126	11.7	54	53.7
Lota lota	(8.4)	(14.8)	(2.7)	(7.6)
Yellow perch	1	-	75	3.7
Perca flavescens	(0)	-	(3.7)	(0.5)
Walleye	6	5.5	42	26.5
Stizostedion vitreum	(0.4)	(7.2)	(2.1)	(3.7)
Total	1500	752.3	2016	705.6
Average/net set	150	75.23	168	58.8

* Percentage of total catch

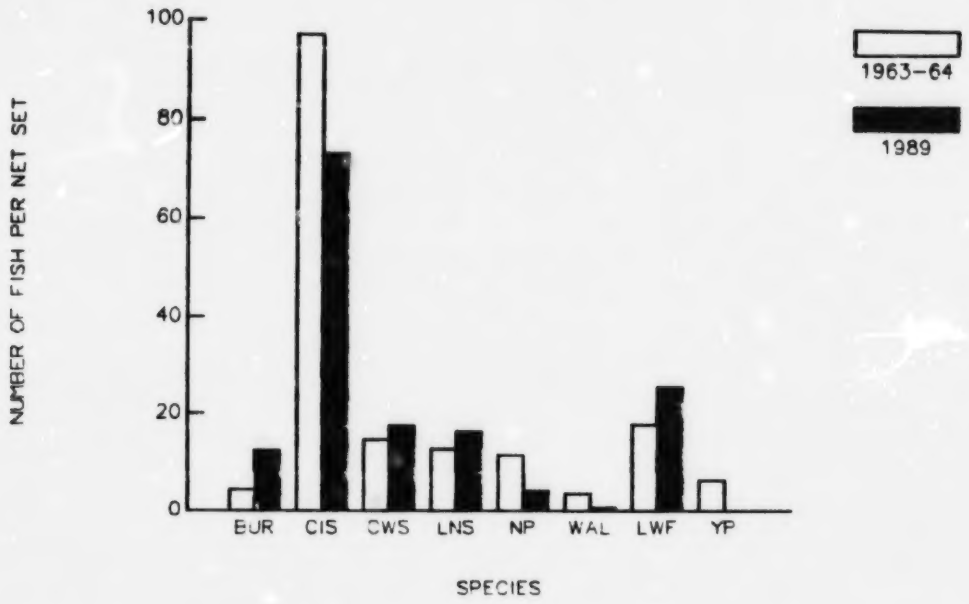

Fig. 3. Frequency distribution of fish species caught in gill nets in Mirond Lake in 1963-64 and 1989.

lake whitefish, common white suckers, and longnose suckers. These four species comprised over 80% of the total catch in both studies. In 1963-64, northern pike was the fifth most prevalent species, followed by yellow perch, burbot, and walleye. In the current study, burbot was the fifth most abundant species, followed by northern pike, walleye, and yellow perch.

The total number of fish caught in 1989 was less than the total number taken in 1963-64, but the total weight of fish in 1989 was 6.7% greater than that of the 1963-64 catch (Table 2). With the exception of burbot, fish were generally heavier in the current study (northern pike were on average 950 g heavier in 1989). Ciscoes comprised the greatest portion of the total catch weight (21.9%) in 1989, followed by suckers, lake whitefish, burbot and northern pike. In 1963-64, northern pike constituted the heaviest portion (29.5%) of the total catch followed by ciscoes, suckers, burbot, and walleye.

4.2 CHARACTERISTICS OF MAJOR SPECIES

4.2.1 Lake Whitefish

Lake whitefish in Mirond Lake were most vulnerable to the 7.6 cm and 10.2 cm mesh sizes (Fig. 4), which accounted for 60% of the whitefish catch for the year. These fish were generally greater than 35 cm in fork length.

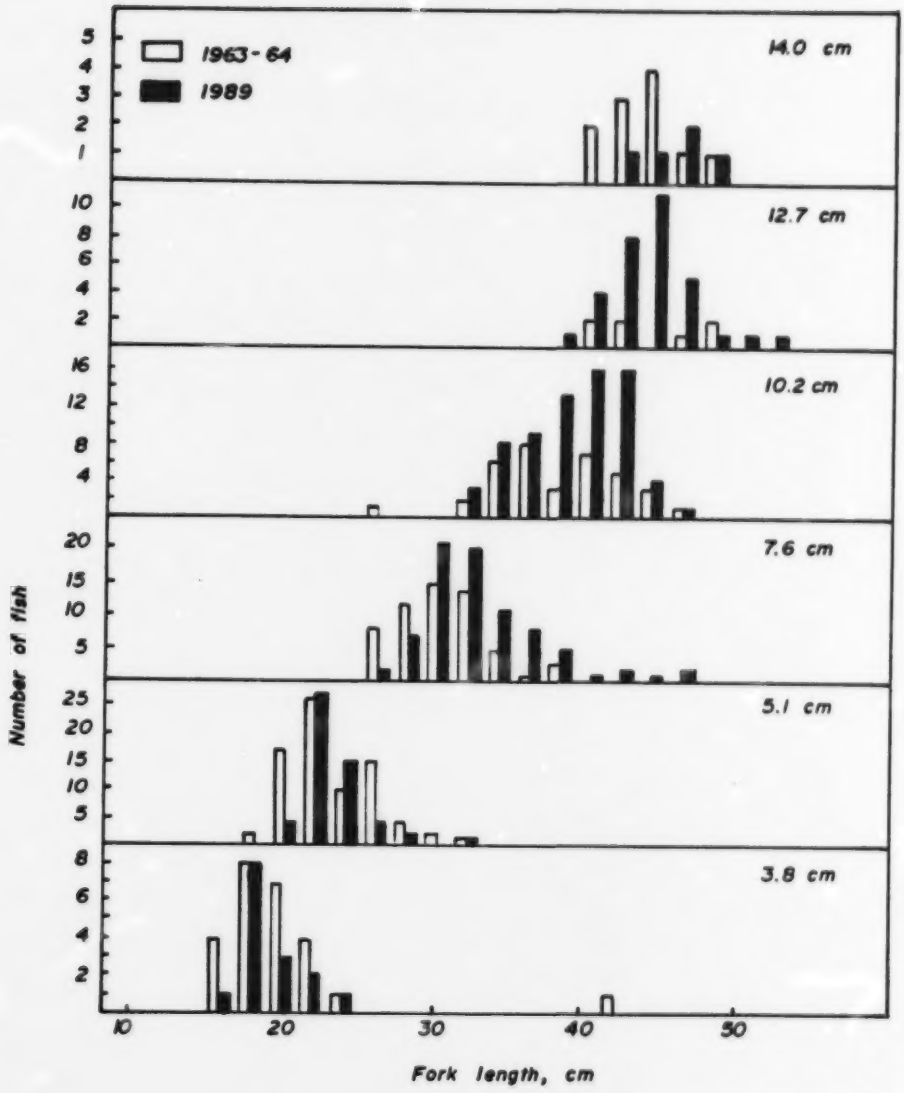

Fig. 4 Length frequency distribution of lake whitefish captured in various mesh sizes of gillnet in Mirond Lake in 1963-64 and 1989.

In 1963-64, lake whitefish were smaller and this was reflected in the mesh sizes of 5.1 cm and 7.6 cm producing 62% of the total catch, with fish 26-46 cm in fork length.

Comparisons of the curves illustrating the relationship between weight and length for lake whitefish caught in both studies (Fig. 5) indicates no difference in condition between those fish caught in 1963-64 and those caught in the present study.

The length frequency distributions of whitefish taken in both studies are shown in Fig. 6. Modes in the distribution of those fish caught in 1963-64 occur at 22 cm, 26 cm, and 40-42 cm representing fish 2, 4, and 7-8 years of age (Johnson, 1967). Three modes in the distribution of the fish taken in 1989 occur at 22 cm, 32 cm, and 42 cm and represent age classes 3, 6 and 11.

Whitefish ages were determined using scales in both 1963-64 and 1989. Age composition and growth of whitefish are shown in Fig. 7. In the current study ages ranged from 1 to 13 years with good representation in all age groups younger than 11 years. In 1963-64, 78 fish were aged. Estimates ranged from 1 to 12 years with 56% of the samples being 4 years of age and younger. Growth curves for the 1963-64 and 1989 whitefish populations in Mirond Lake illustrate that fish in the current population growth at a slightly reduced rate than those from the earlier study.

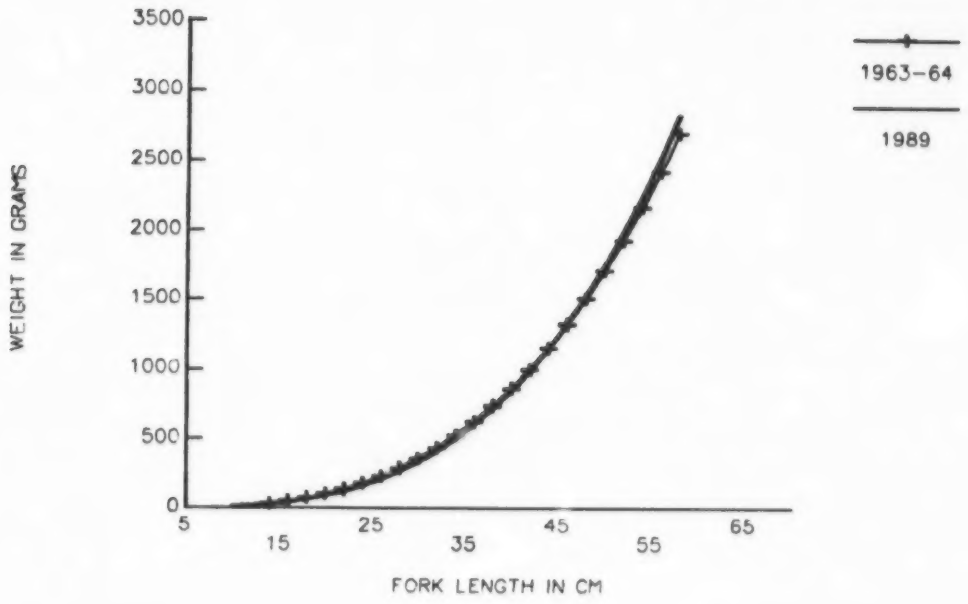

Fig. 5. Weight - length relationships of lake whitefish caught in gill nets in Mirond Lake in 1989 and 1963-64. (1989: $W=0.010144*L^{3.077174}$; 1963-64: $W=0.005124*L^{3.2568}$) W is weight in grams; L is fork length in cm.

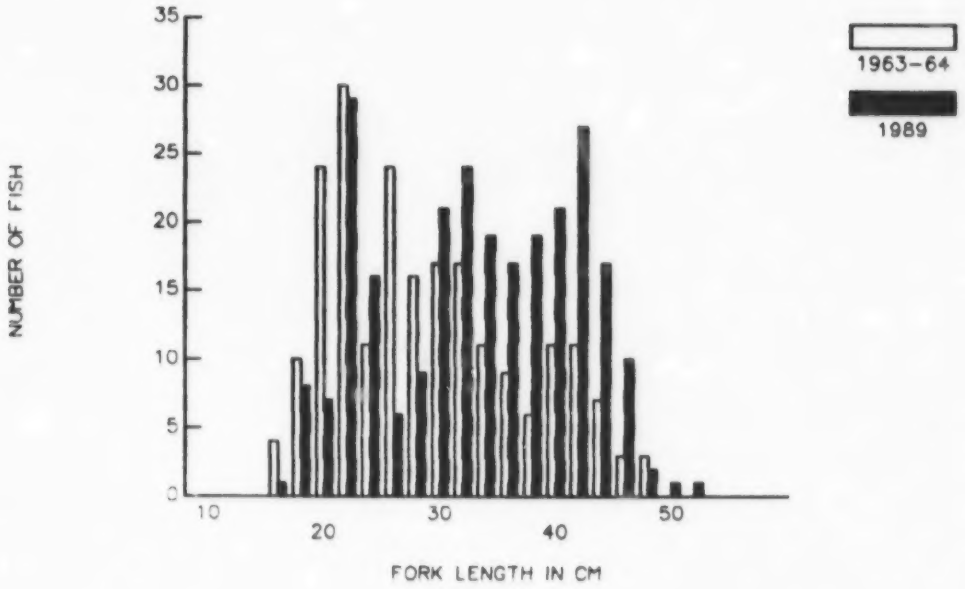

Fig 6. Length frequency distribution of lake whitefish caught in gill nets in Mirond Lake in 1989 and 1963-64.

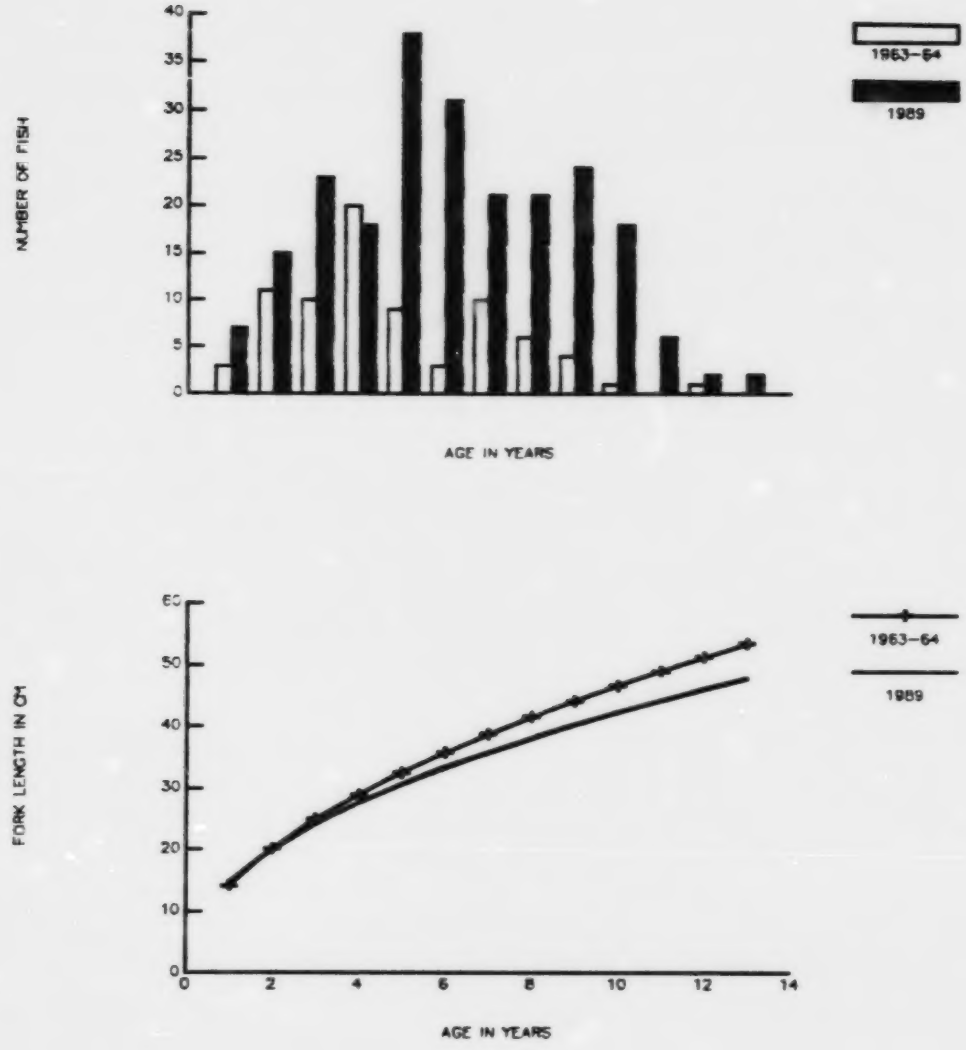

Fig. 7. Age distribution and growth of lake whitefish caught in gill nets in Mirond Lake in 1989 (n=266) and 1963-64 (n=78).

The sex ratio of whitefish in Mirond Lake is approximately 1 male to every female. All fish younger than 4 years of age were immature (Appendix 1). Males older than 6 years were mature, and only 12% of the 6 year olds were immature. Females achieved maturity no later than 6 years of age, however one 8 year old was immature. Average length at maturity was 33.6 cm.

No quantitative data on the diet of lake whitefish were acquired during the course of the study. A qualitative assessment revealed that chironomids and sphaerid clams were the major food items of this species. In 1963-64, *Pontoporeia*, a deepwater amphipod, was the preferred food of whitefish at all depths in Mirond Lake (Johnson, 1967).

4.2.2 Northern Pike

The number of northern pike caught in gill nets in 1989 was substantially smaller than that caught in the 1963-64 study (Table 2). This is probably the result of not setting nets in the Wunehikun Bay area, where 60% of the 1963-64 pike catch was obtained.

Northern pike are generally caught by their teeth in gillnets, becoming entangled by rolling in their attempts to free themselves (Johnson, 1967). The result is that catchability of pike tends to be fairly uniform across the 3.8 cm to 10.2 cm mesh sizes and does not reflect fish size as it does in other species. The two larger mesh sizes are virtually ineffective in catching pike.

Fish removed from nets in 1989 fell within the mid to upper range of the length frequency distribution of pike caught in 1963-64 (Fig. 8). The smallest fish was 52.5 cm in fork length and the largest was 70.4 cm (Table 3). In the earlier study, fork lengths ranged from 31.2 cm to 77.0 cm. In both samples, the average fork length was 59.9 cm. Weights ranged from 1050 g to 2550 g with a mean weight of 1641.9 g in 1989 and from 96 g to 3147 g with a mean weight of 1500.7 g in 1963-64.

Fig. 9 shows the weight-length regression curves for fish from both studies. These curves clearly illustrate that pike caught in the current study were heavier per unit length than were those taken in 1963-64.

In 1963-64, ages of northern pike were estimated from scales. In the current study, scales and cleithra were both used as aging media for pike. Many scale samples were unreadable due to regenerative growth and as a result, ages for the 1989 pike population were based upon estimates made from cleithra. Age composition and growth of pike in 1989 and 1963-64 are shown in Fig. 10.

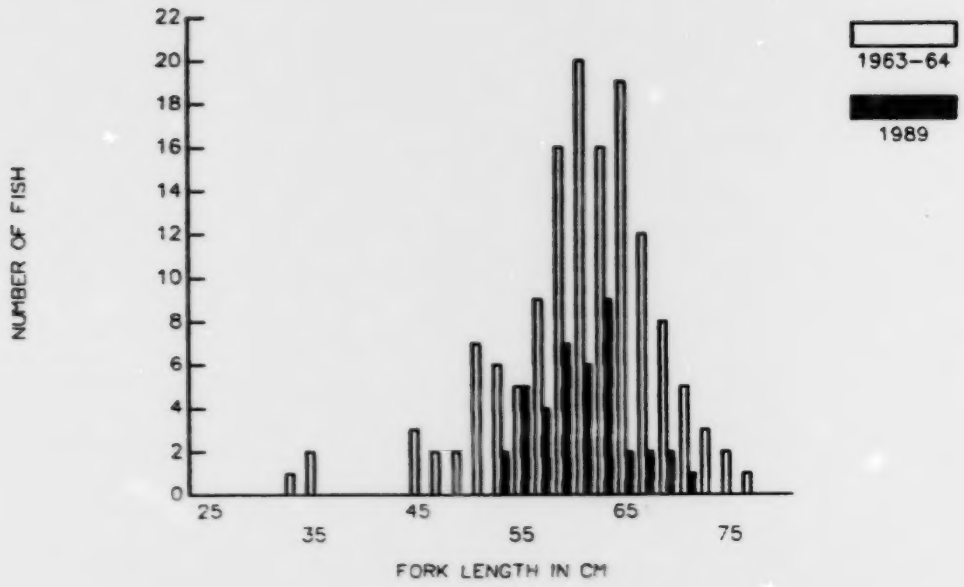

Fig. 8. Length frequency distribution of northern pike caught in gill nets in Mirond Lake in 1989 and 1963-64.

Table 3. Length and weight data for three fish species caught in gillnets in Mirond Lake in 1963-64 and 1989.

Species		1963-64 Length (cm)	1963-64 Weight (g)	1989 Length (cm)	1989 Weight (g)
Cisco	Mean	21.8	81.0	27.1	286.4
	Max	38.4	822	38.3	1025
	Min	5.3	28	14	35
Lake whitefish	Mean	27.9	380.1	32.3	527.7
	Max	47.8	2778	51.9	1950
	Min	14.5	37	15.5	35
Northern pike	Mean	59.9	1500.7	59.9	1641.9
	Max	77	3147	70.4	2550
	Min	31.2	96	52.5	1050

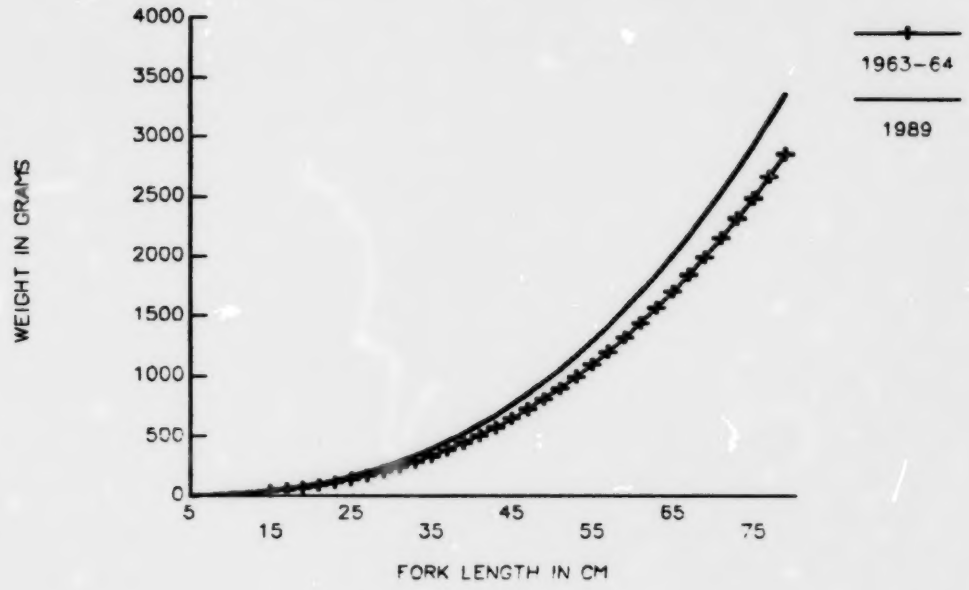

Fig. 9. Weight - length relationships of northern pike caught in gill nets in Mirond Lake in 1989 and 1963-64.

(1989: $W=0.03247*L^{2.642697}$; 1963-64: $W=0.027163*L^{2.646339}$)

W is weight in grams; L is fork length in cm.

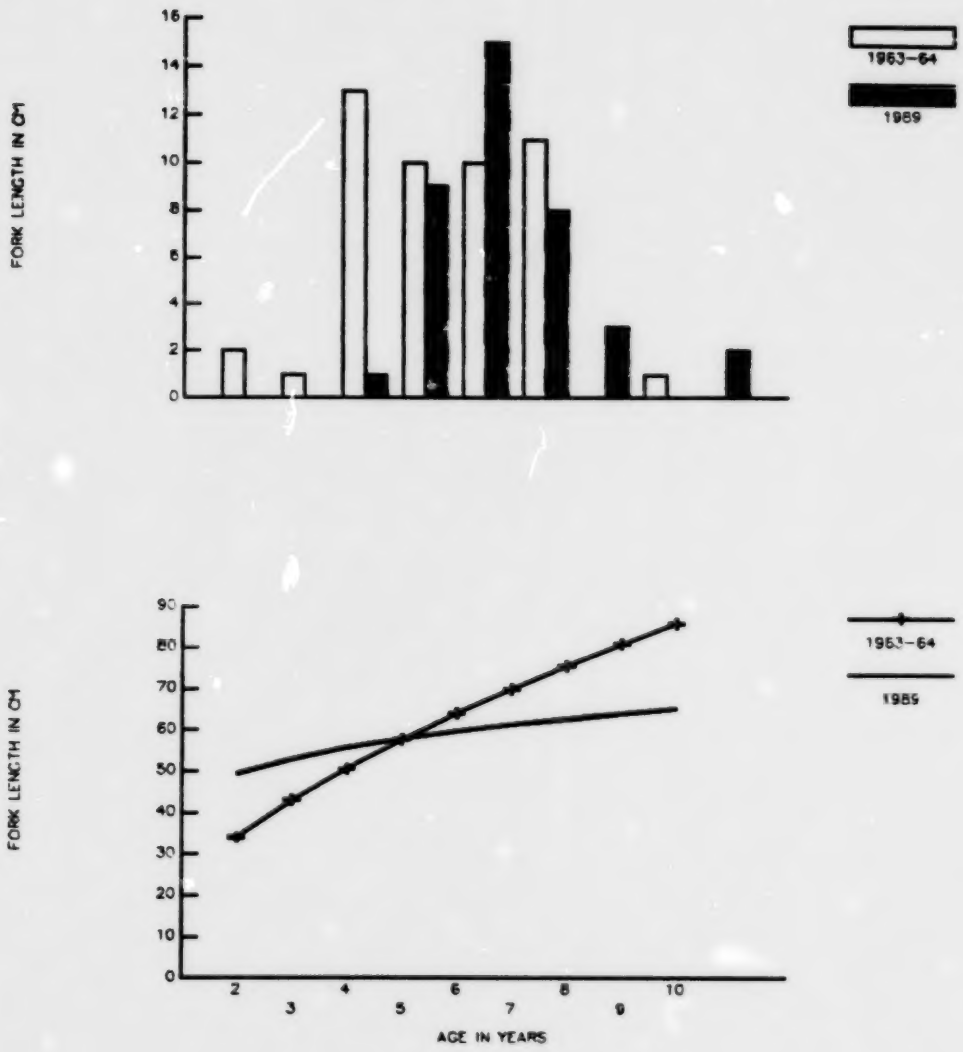

Fig. 10. Age distribution and growth of northern pike caught in gill nets in Mirond Lake in 1989 (n=38) and 1963-64 (n=48).

The current population was characterized by a lack of fish 4 years and younger. A few 8 and 10 year olds were caught but 5, 6, and 7 year olds made up 84% of the sampled fish, all of which were mature. The predominant age group was that of 6 year olds. In the earlier study, ages 4 thru 7 were well represented. Only a few 2 and 3 year olds were caught and 9 years was the maximum.

The growth curve representing pike from the current population, suggests a rapid growth rate in the first year of life, after which growth moderates to a much reduced level. The growth rate of fish from the earlier study was more rapid but fairly uniform throughout all age classes

The diet of northern pike from Mirond Lake was difficult to ascertain. Sometimes, upon becoming entangled in a net, a fish will regurgitate the contents of its stomach. Thirty-one of the 38 pike stomachs examined in 1989 were empty. The remainder contained unidentifiable fish remains. In 1963-64, fish formed 89% of the diet of pike from Mirond Lake (Johnson, 1967).

4.2.3 Cisco

Mesh sizes of gillnet smaller than 10.2 cm were most effective in catching ciscoes in Mirond Lake. In 1989, 81% of ciscoes were caught in the 5.1 cm and 7.6 cm mesh sizes, while in the earlier study, 85% of ciscoes caught were removed from the 3.5 cm and 5.1 cm mesh sizes. The difference in mesh selectivity between studies reflects

a difference in the size of fish between years. Some ciscoes were tangled in the larger mesh sizes, but generally any mess larger than 7.5 cm was relatively ineffective.

Cisco numbers were notably smaller in 1989 than they were in 1963-64 (Table 2), however, the present study yielded a greater number of larger fish (Fig. 11). The average cisco removed from gillnets in 1989 had a fork length of 27.1 cm and weighed 286.4 g (Table 3). Fork lengths ranged from 14 cm to 38.3 cm and weights were from 35 g to 1025 g. In the earlier study, the mean fork length was 21.8 cm with a range of 5.3 cm to 38.4 cm. Average weight was 81.0 g ranging from 28 g to 822 g.

4.3 UTILIZATION OF THE FISHERY RESOURCE

Commercial fishing on Mirond Lake dates back to 1932. In 1941, the first quota restriction of 34 00 kg was imposed, and included lake whitefish, walleye, and lake trout. In 1942-43, the quota rose to 45 400 kg where it remained for the next 26 years. In 1968-69, the weight allowance was established at 36 300 kg and included whitefish only. The current quota of 36 300 kg with a 10% restriction on trout, walleye, and pike was implemented in 1969-70.

Restrictions on legal mesh size in Mirond Lake date back to 1953, at which time, 12.7 cm mesh was the size approved for catching lake trout, whitefish, and walleye. In 1954, this was reduced to 11.4 cm for walleye to facilitate a better harvest of the mature population.

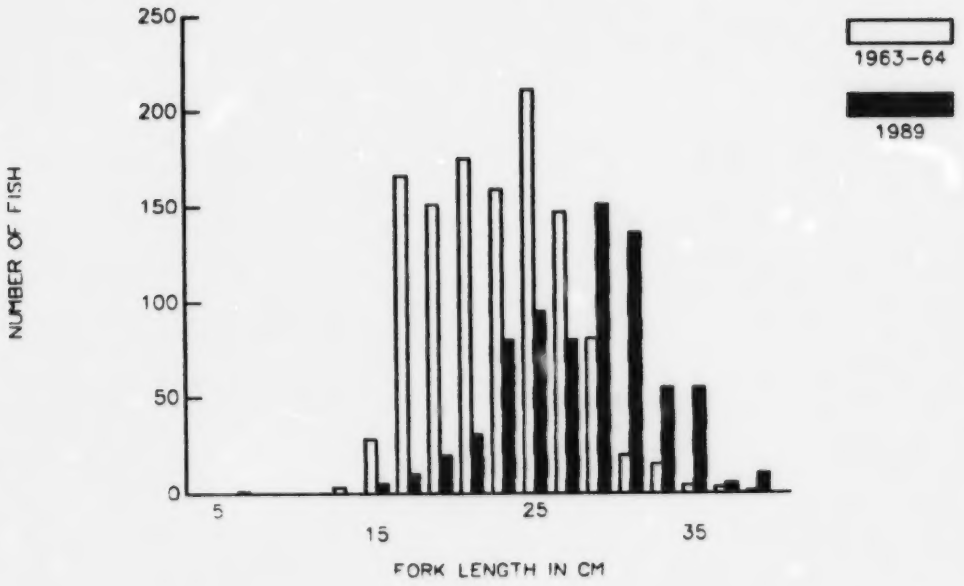

Fig. 11. Length frequency distribution of cisco caught in gill nets in 1989 and 1963-64.

In 1962, it was increased again to 12.7 cm in response to a potential conflict between commercial and recreational fishermen. The current mesh size of 11.4 cm for all species was authorized in 1965.

The number of commercial licenses issued annually since 1932 has varied from 1 to 34, and total fish production has ranged from a low of 1711 kg in 1981-82 to a high of 180 887 kg in 1939-1940 (Appendix 2). An average of 3.14 kg/ha was harvested annually over the last 57 years, and was comprised of 78.7% whitefish, 8.4% walleye, 3.3% trout, and 7.4% northern pike. Other fish species comprised 2.0% of the average annual harvest.

In 1989, 3 commercial licenses were issued and total production yielded 3048 kg. Lake whitefish comprised 99% of the harvest, with walleye and pike making up the remainder. In the years of the commercial fishery prior to 1969 and the 10% gamefish restriction, whitefish averaged 73% of the total catch annually, with walleye and pike comprising as much as 42% (1949-50) and 21% (1961-62), respectively. Since 1969-70, the 10% gamefish restriction has been exceeded on 3 occasions. Lake trout production reports virtually ceased after 1945, with only a total of 13 kg of trout being reported in 3 succeeding years.

Average commercial production for each decade since 1932 is shown in Table 4. Production peaked in the 1930's with an average

Table 4. Average commercial fish production ($kgx10^3$) on Mirond Lake in each decade since 1932.

	Whitefish	Walleye	Trout	Pike	Other	Total	No. Licenses
1932-39	47.1	1.2	3.1	1.4	2.9	55.7	45
1940-49	19.9	2.1	3.5	2.9	1.7	30.2	106
1950-59	33.6	5.3	2.2	4.2	-	45.4	231
1960-69	31.3	5.1	0.4	6.7	-	43.5	217
1970-79	22.1	1.1	-	1.0	0.04	24.2	208
1980-89	6.7	0.3	-	0.1	0.01	7.1	56

annual yield of 55 700 kg. Production dropped to 30 200 kg in the 1940's in spite of the increased number of licenses issued, but rose again in the 1950's to 45 400 kg. Over the last 3 decades, the annual commercial harvest has exhibited a downward trend. Fishing effort has also declined.

Records of total Indian harvest are available for 1984 to 1989 (Appendix 3). However, it has been believed that these records underestimate the harvest by a factor of 10 (Murray and Clouthier, 1986). Adjusting for this, the native fishery, between 1984 and 1989, harvested an annual average of 12 620 kg: 14% whitefish, 18% walleye, 14% northern pike, and 54% "rough" fish species (ciscoes, burbot, suckers). The commercial fishery, for the same period of time, produced 8500 kg yearly, comprised of 95% whitefish, 4% walleye, and 1% northern pike.

Data on angler harvests from Mirond Lake are virtually non-existent. However, for the 1987-88 season, potential harvest by the sport fishery was estimated at 44 600 kg, comprised of 44% walleye and 56% pike (Walton, 1988). These values are crude estimates only, representing a minimum of the recreational yield, and were obtained from the outfitters using the following criteria:

Total number of beds -	140
Occupancy rate -	35%
Length of stay -	3 days
length of season -	180 days
Average size of fish - walleye:	1.0 kg
pike:	1.2 kg

Table 5. Estimated average user harvest (kg x 10^3) of fish from Mirond Lake from 1984 to 1989.

User	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total
Commercial	8.05	0.33	-	0.11	-	8.49
Indian	1.80	2.30	-	1.70	6.82	12.62
Angler*	-	19.6	-	25.0	-	44.60
Total	9.85	22.23	-	26.81	6.82	65.71

*Minimum potential angler harvest as estimated by Walton (1988) for Mirond Lake for the 1988 season.

Between 1984 and 1989, estimated total yearly harvest of the Mirond Lake fishery by all user groups was 65 710 kg or 6.04 kg/ha (Table 5). The recreational fishery harvested approximately 68% of this total.

5. DISCUSSION

5.1 FISH POPULATIONS

The Mirond Lake fishery is comprised of eight species of large fish. Although Johnson (1967) reported the presence of lake trout in 1963-64, their occurrence was rare and none were taken in the test nets. Compared to other Saskatchewan water bodies, such as Montreal Lake (90 gamefish/net; Merkowsky and Sawchyn, 1988), Tobin Lake (70.6 gamefish/net; Durbin, 1981), and Jackfish Lake(47.3 gamefish/net; Durbin 1980), Mirond Lake (4.6 gamefish/net) is very low in gamefish abundance.

Lake whitefish abundance, however, compares favorably to other lakes in the province. The average catch of 25.5 whitefish per net set represents a high abundance of this species:

Water body	No. of Whitefish/set	Source
Pinehouse L.	17.2	Liaw 1988
Dore L.	15.2	Sawchyn 1987
Delaronde L.	9.9	Liaw 1976
Montreal L.	9.0	Merkowsky and Sawchyn 1988

Lake whitefish in Mirond Lake grow more slowly than whitefish in Montreal Lake (Merkowsky and Sawchyn, 1988) and Pinehouse Lake (Liaw, 1988) but at a rate comparable to the whitefish populations in 4 lakes west of Sandy Bay (Liaw, 1986). The present population exhibited a slower pattern of growth when compared to the earlier study, however, fish condition was similar between years.

The whitefish population was characterized by an abundance of age classes with good representation in each. The presence of numerous older and larger fish in the 1989 population may be responsible for the observed depressed growth rate, as these fish would consume larger quantities of food at the expense of younger smaller fish but with less resultant growth.

The greater number of older fish is the result of reduced harvest pressure in the years preceding the study (Appendix 2). The marketability of these fish depends highly upon the rate of infestation of cysts of the tapeworm *Triaenophorus crassus*. Fish with infestation levels exceeding 80 cysts per 45 kg are classified as "C", or cutter fish and cannot be marketed for human consumption within Canada unless cysts are removed. Levels exceeding a 40 cysts per 45 kg tolerance limit cannot be exported. In 1951, cyst infestation levels were 45 cysts per 45 kg and whitefish were given a borderline "A" classification wherein they could be marketed without restriction (Johnson, 1967). In 1985, however, cyst infestations showed an increase and lake whitefish

were classified as "C" fish. This is reflected in the greatly reduced commercial harvest in 1986-88; the classification currently stands.

The lack of walleye in the gillnet catches is the result of test nets being set at mean depths greater than 10 m (Appendix 4). Johnson (1967) reported that walleye in Mirond Lake showed a preference for water less than 10 m in depth. In 1988, 44% (19 600 kg) of the recreational harvest was comprised of walleye. During the summer of 1989, anglers were reportedly having great success in catching walleye in water 2-4 m deep (B. Humen, pers. comm.). It can be concluded that results from test nets in 1989 may have underestimated the abundance of walleye in Mirond Lake.

The population of northern pike in Mirond Lake was characterized by a significant lack of young fish, and only a few old fish. In the 1963-64 study, there were also very few young, or old fish caught (Johnson, 1967). Availability of shallow, weedy areas typically used by pike for spawning (Scott and Crossman, 1973) are scarce in Mirond Lake. Access to small streams that offer such habitat is often prohibited to these fish as a result of beaver activity, or low water conditions. The lack of young age classes may reflect unsuccessful reproduction in the years prior to the current study. However, if this were the case, both at the time of the earlier study as well as the present study, the current suggested levels of harvest would have resulted in a severe depletion of the pike stocks before now. In addition, pike are the definitive hosts of the tapeworm *T. crassus*.

Reduction in pike numbers has been suggested as a control measure for cyst infestation in whitefish (Miller, 1944). The fact that whitefish in Mirond Lake have high infestations of these cysts is indicative of a fairly healthy pike population. Pike prefer shallow water and, subsequently, the observed age structure is more probably an artifact of the 1989 test nets being set in water having a mean depth greater than 10 m; too deep to catch small, young pike, and too deep to catch larger fish foraging in the shallows.

The growth rate of the current pike population was determined from a small sample size which may cast some doubt on the veracity of the curve. For pike aged 1-5 years the rapid growth is faster than that of similar aged fish in 4 lakes of the Churchill River system (Liaw, 1986), but is comparable to growth rates observed for the same age group of pike in Montreal Lake (Merkowsky and Sawchyn, 1988), Pinehouse Lake (Liaw 1988), and Jackfish Lake (Durbin 1980). Older fish in Mirond Lake grow at a relatively slower rate when compared to the aforementioned populations.

The health of a population of forage fish can be an index to the health of resident gamefish populations. Ciscoes, while not economically significant, are an important forage species. Johnson (1967) reported that age determination of ciscoes in the Jan-Pelican-Mirond lake chain revealed abnormal variations in growth and suggested the presence of more than one species. He further pointed out that at that time, the Mirond Lake population was comprised of a smaller race.

Although ciscoes were less numerous in Mirond Lake in 1989, the population was healthy, made up of fish that were larger and more robust than those sampled in the earlier study. This suggests that growing conditions for this species have improved between study years, or there has been immigration of the larger race from the other lakes in the chain.

Yellow perch were virtually absent from the gillnet catches in 1989. As was discussed previously, this is probably the result of the deep net sets. Seining data collected from Mirond and other lakes in 1963-64 (Johnson, 1967) suggests that gill nets do not provide an adequate method of obtaining a representative sample of the yellow perch population in some lakes. Johnson (1967) found that yellow perch made up over 68% of the fish collected by seining the littoral zone of Mirond Lake in 1963-64 and over 80% of the 2000 fish similarly collected in Jan Lake in the same year.

The lake trout population in Mirond Lake virtually ceased to exist after 1970. This could be due to the marginal habitat for this species since only 9% of the lake area overlies depths which provide suitable summer habitat for lake trout. Increased angling pressure in the 1960's appears to have been sufficient to extirpate the species.

5.2 LAKE PRODUCTIVITY

The determination of potential fish yield within a lake is necessary for the successful management of the utilization of the resource. The most highly recognized estimator of potential fish yield is the morphoedaphic index (Ryder et al., 1974), which was originally described as a general method of calculating fish yields from north-temperate lakes and is defined as the ratio of total dissolved solids (TDS) and mean depth (z) (Ryder, 1965). Recently, other regression models have been developed, incorporating factors more closely related to fish productivity in a functional sense. Two of these models include macro benthos biomass (wet weight) in relation to mean depth (Hanson and Leggett, 1965) and the standing crop of bottom fauna (dry weight) (Matuszek, 1978). Estimates of potential maximum sustainable yield (MSY) from Mirond Lake were calculated from the three models shown below using data obtained from Johnson (1967):

Model[1]	MSY kg/ha/yr	MSY kg/yr
Total, $Y=0.966\sqrt{MEI}$ (Ryder, 1965)	2.47	26 900
Total, $0.007M+0.018TDS-0.053z$ $+0.00007A_o+0.793$ (r^2=0.66 Hanson and Leggett, 1982)	2.22	24 150
Total, $C_t/A=-0.5524+4.9307\log BFWT$ (r^2= 0.828, Matuszek, 1978)	4.52	49 200

[1]MEI=morphoedaphic index, TDS/z; M=wet weight of bottom fauna, 71.52 kg/ha; TDS=total dissolved solids, 92 mg/L; z=mean depth, 14.0 m; A_o=water area, 108.8 km^2; C_t/A, y=total sustainable yield; BFWT=dry weight of bottom fauna, 10.7 kg/ha.

A comparison of the potential yields reveals that all three methods gave similar estimates. However, the predictive power of the MEI has come under scrutiny in the last few years. Matuszek (1978) reported that macro benthos standing crop was a much stronger index of fish productivity, accounting for up to 82.8% of the variability in the total fish yield, while the model proposed by Hanson and Leggett (1982) using macro benthos biomass explained 66% of the variation in the total fish yield.

The MSY derived from Matuszek's (1978) model incorporates biotic elements, explains the greatest amount of the variation in yield, and at the same time provides the highest total fish yield. For these reasons, this model was accepted as the best indicator of potential fish yield in Mirond Lake. Thus, the potential maximum sustainable for all fish species from Mirond Lake was 4.52 kg/ha or 49 200 kg. This is comparable to estimates of maximum sustainable yield for other lakes in the region (Liaw, 1986).

Sustained yields of the highly valued species of walleye, whitefish and northern pike are given below, and were determined from MSY using the percent composition by weight in the total gillnet catch for 1989 (from Table 2):

Species	% catch by wt.	Est. yield kg/ha/yr	Est yield kg/yr
Walleye	7.2	0.33	3590
Pike	13.0	0.59	6419
Whitefish	17.7	0.80	8704
Total	37.9	1.72	18 713

Estimated yields for walleye, pike and whitefish in Mirond Lake were similar to a range of estimates from other lakes located near the southern border of the Precambrian Shield (from Liaw, 1986):

Lake	Maximum sustainable yield, kg/ha/yr		
	Walleye	Pike	Whitefish
Jan	0.33	0.59	0.80
Guilloux	0.24-0.92	0.19-0.63	0.58-0.92
Pikoo	0.72-0.79	0.60-0.66	0.88-1.37
Reeds	0.50-0.85	0.41-0.70	0.75-1.10
Sokatisewin	0.36-0.70	0.29-0.58	0.66-0.94

5.3 MANAGEMENT IMPLICATIONS

A comparison of the estimated total harvest records from the last 5 years (65 710 kg) and the estimated maximum sustainable yield (49 200 kg) suggests that Mirond Lake is overexploited. Although whitefish are being harvested at a level well below the estimate of maximum sustained yield (8700 kg) for this species, harvests of pike (26 810 kg) and walleye (22 230 kg) are in excess of the total allowable catch suggested by the MSY for these species. Based on a comparison of the harvest records and the available population data, current pike stocks are probably able to withstand a higher level of harvest than suggested. Estimates of total allowable catch for walleye based on the available data cannot be made with any confidence.

6. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY AND CONCLUSIONS

1. A fishing survey was undertaken in Mirond Lake to evaluate the status of the resource and compare it to the results found in an earlier study conducted in 1963-64.
2. Mirond Lake is situated in east central Saskatchewan, approximately 80 km west of Flin Flon. It lies near the southern edge of the Precambrian Shield and has a water area of approximately 10,880 hectares. Average water depth is 14.0 m with a maximum depth of 45.5 m.
3. A commercial fishing industry, as well as 3 licensed outfitters and 2 privately owned campgrounds currently rely upon the fishery resource in the lake. Only one outfitter was fully operational for angling in 1989.
4. The Mirond Lake fishery is comprised of eight species of large fish. These did not include lake trout.
5. The average number of fish caught per standard gang of gillnet suggest a decrease in overall abundance: 168 fish/net in 1963-64 to 150 fish/net in 1989.
6. Ciscoes were the most abundant fish in the gill nets, followed by lake whitefish, common white sucker, and longnose sucker. These 4 fish species collectively comprised over 80% of the total catch.

7. Forty pike, 6 walleye, and 1 perch were caught. These species were not a large component of the total catch as a result of the gill nets being set in depths greater than 10 m.
8. The lake whitefish population in Mirond Lake is healthy. The majority of fish caught were over 35 cm in fork length and weighed more than 0.5 kg. The growth rate of whitefish was slower in 1989 than in 1963-64 but fish condition was similar. All age groups, particularly older age groups, were well represented. This is due to reduced fishing pressure which has resulted in the presence of a larger number of older fish in the population. Sexual maturity occurred no later than 6 years of age in males, but could be as late as 8 years in females. Sphaeriid clams and midge larvae were the major dietary item of whitefish.
9. Northern pike was the most abundant gamefish species in the gill nets. Sizes ranged from 31 cm to 77 cm but the majority were greater than 55 cm in length and weighed over 1 kg. In 1989, ages ranged from 4-10 year and 84% of the sampled pike population fell into the 5-7 year age classes. In 1963-64, ages 4 thru 7 were well represented. Only a few younger and older fish were caught. Results suggest that only the older and larger component of the population was sampled.
10. Fewer cisco were caught in 1989 but the population was comprised of larger and more robust fish than were found in 1963-64, suggesting

improved living conditions for this species, or possibly immigration from other areas.

11. Commercial fishing records for Mirond Lake are available since 1932. Number of commercial licenses issued since that time has ranged from 1 to 34. The commercial quota is currently 36 300 kg with a 10% tolerance limit on walleye, pike, and trout. Average annual production over the last 57 years is 3.14 kg/ha with 78.7% whitefish, 8.4% walleye, 3.3% trout, and 7.4% pike. Since the 1960's, annual production has been declining.
12. There is a lack of accurate harvest information by other resource users (i.e. Indian fishermen and anglers). Between 1984 and 1989, however, the average annual Indian harvest was estimated at 12 620 kg. Angler harvest for 1988 was estimated to be 44 600 kg.
13. Macrobenthos standing crop was used to estimate the fish yield in Mirond Lake. The maximum sustainable yields suggest that total allowable catch not exceed 3590 kg for walleye, 6400 kg for pike, and 8700 kg for whitefish, or 49 200 kg for all species. A comparison of actual harvest with these estimates indicates that production on Mirond Lake greatly exceeds the estimated sustained yield.

6.2 RECOMMENDATIONS

1. Retention of the current commercial quotas and harvest regulations.
2. Recreational and native fisheries surveys should be conducted to obtain accurate information on these harvests from Mirond Lake in both summer and winter seasons.
3. Supplementary testnetting should be conducted in those areas of the lake less than 10 m in depth. This would provide the additional data required to adequately assess the lake, particularly with regard to pike and walleye stocks.
4. Maintain the present recreational allocation levels until such time that a more representative assessment of the lake is made.
5. Derive a method for determining estimates of maximum sustainable yield that can be confidently used in determining total allowable catch.
6. Ensure that, in future fisheries studies, all depth zones of a lake are adequately sampled.

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8. APPENDICES

Appendix 1. Age and state of maturity of lake whitefish caught in gillnets in Mirond Lake in 1989.

Age	Male		Female	
(y)	Mature	Immature	Mature	Immature
1	0	2	0	0
2	0	5	0	7
3	0	9	0	12
4	5	9	1	4
5	7	12	8	11
6	17	2	9	0
7	12	0	9	0
8	11	0	11	1
9	14	0	11	0
10	7	0	11	0
11	4	0	2	0
12	1	0	1	0
13	2	0	0	0

Appendix 2. History of the commercial fishery production on Mirond Lake from 1932 to 1989 inclusive (weight in kilograms).

Year	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total	No. Licenses
1932-33	19686	2767	1315	1814	3039	28621	9
1933-34	29932	506	4049	907	3629	39023	5
1934-35	36717	278	4806	497	2087	44385	5
1935-36	29325	599	2429	1585	3629	37567	3
1936-37	28984	4051	3514	2285	2268	41102	4
1937-38	24235	328	3175	454	1814	30006	4
1938-39	34474	844	933	3175	4606	44032	9
1939-40	173502	368	4340	590	2087	180887	6
1940-41	14176	1248	1091	1248	6804	24567	7
1941-42	5670	907	522	454	794	8347	3
1942-43	18330	3065	5507	789	1905	29596	11
1943-44	30152	9380	2288	5076	5775	52671	14
1944-45	26711	2001	1384	1306	998	32400	11
1945-46	34053	1319	737	3310	-	39419	18
1946-47	3657	42	55	64	-	3818	2
1947-48	32256	1009	860	-	-	34125	11
1948-49	34219	1064	1264	-	-	36547	12
1948-49	34219	1064	1264	-	-	36547	12
1949-50	21683	16855	980	924	-	40442	17
1950-51	29091	16790	1268	4305	-	51454	21
1951-52	38803	4980	2533	8254	-	54570	28
1952-53	42348	992	2096	2242	-	47678	20
1953-54	26308	4219	11728	8373	-	50628	24
1954-55	26970	3429	493	3974	-	34866	24
1955-56	42545	4344	1477	4360	3	52729	31
1956-57	37517	3916	352	2371	-	44156	17
1957-58	24142	2906	278	2340	-	29666	19
1958-59	33985	4613	626	2177	-	41401	26
1959-60	34771	6746	1264	3762	-	46543	21
1960-51	23764	9234	169	7535		40702	14
1961-62	39070	5722	954	12343	-	58089	23
1962-63	48776	2752	831	5630	-	57989	26
1963-64	44665	3945	228	4018	-	52856	21
1964-65	28917	7447	508	12100	-	48972	20
1965-66	33658	4280	95	5173	-	43206	13
1966-67	26886	3346	529	3820	-	34581	20
1967-68	19211	9565	112	10064	-	38952	28

Appendix 2. History of the commercial fishery production on Mirond Lake from 1932 to 1989 inclusive (weight in kilograms). (continued)

1968-69	21479	3663	64	4407	-	29613	21
1969-70	26439	1364	139	1797	-	29739	31
1970-71	28163	1211	-	1436	-	30810	31
1971-72	25118	787	-	1214	-	27119	34
1972-73	19108	309	-	468	-	19885	15
1973-74	27549	2594	1	1486	-	31630	20
1974-75	33430	1324	-	1272	369	36395	26
1975-76	30361	2284	-	1936	-	34581	21
1976-77	29079	1277	-	953	-	31309	21
1977-78	19415	907	9	444	-	20775	20
1978-79	4621	139	-	196	46	5002	12
1979-80	3871	224	-	244	-	4339	8
1980-81	5557	290	-	240	-	6087	9
1981-82	1493	47	-	171	-	1711	7
1982-83	9150	456	-	242	-	9848	8
1983-84	10743	16	-	46	-	10805	6
1984-85	2534	12	-	15	150	2711	6
1985-86	34743	1812	-	388	-	36943	14
1986-87	-	-	-	-	-	-	3
1987-88		no					fishing
1988-89	3025	16	-	7	-	3048	3
Total	1535067	1164589	65003	144281	40003	1948943	863
% total	78.7	8.4	3.3	7.4	2.0	100	
Average	26931.0	2887.5	1140.4	2531.2	701.8	34191.9	
kg/ha/yr	2.48	0.27	0.10	0.23	0.06	3.14	

Appendix 3. History of the Indian harvest (in kg) in Mirond Lake between 1984 and 1989.

Year	Lake Whitefish	Walleye	Trout	Northern Pike	Other	Total
1984-85	300	100	-	200	600	1200
1985-86	200	500	-	500	1500	2700
1986-87	200	500	-	100	400	1200
1987-88		no records				
1988-89	200	50	-	50	910	1210
Total	900	1150	-	850	3410	6310
% total	14.3	18.2	-	13.5	54.0	
Average kg/yr	180	230	-	170	682	1262
Average kg/yr[1]	1800	2300	-	1700	6820	12620
kg/ha/yr	0.17	0.21	-	0.16	0.63	1.16

[1]Adjusted value (Murray and Clouthier, 1986)

Appendix 4. Total number of fish and average length (centimeters) of fish caught per gillnet set in Mirond Lake in 1989. (mean depth in meters)

Net Set	Mean Depth	Whitefish		Walleye		Pike		Cisco		CWSucker		LNSucker		Burbot	
		No.	Length	No.	Length	No.	Length	No.	Length	No.	Length	No.	Length	No.	Length
1	21.5	8	23.8	2	25.4	10	61.4	34	26.1	4	34.7	33	37.4	5	52.4
2	30	32	34	0	0	1	62	20	28.8	0	0	4	39.7	38	47.9
3	14	3	17.9	0	0	9	59.4	46	26.5	10	28.8	11	27.9	2	51.9
4	21	40	33.5	0	0	0	0	31	20.1	0	0	1	40.1	17	51.2
5	17.5	3	21.7	0	0	0	0	29	20.2	24	38.5	27	34.8	0	0
6	17	33	37.3	0	0	0	0	85	26.5	0	0	8	38.5	27	49.3
7	31	57	31.7	0	0	0	0	97	21.6	0	0	8	39.4	30	51.3
8	21.5	11	35.2	0	0	4	58.8	31	16.5	56	39.6	21	38.7	3	53.8
9	21.7	58	31.4	0	0	0	0	60	16.9	6	38.9	50	24.6	4	45.4
10	10	10	22.5	4	45.7	16	5905	299	16.4	76	23.5	0	0	0	0